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YIELD TESTS OF DISEASE-RESISTANT SUGAR CANES IN LOUISIANA

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INTRODUCTION

The extremely low yields recently obtained in Louisiana from the commonly cultivated varieties of sugar cane, D–74, Louisiana Purple, and Louisiana Striped (Ribbon), following practically 100 per cent mosaic infection and accentuated damage from a combination of unfavorable seasons, root rot, and borers, have seriously menaced the cane-growing industry. Fortunately, a few planters heeded the earlier warnings of Brandes (*2*)[2] and others and arranged with the United States Department of Agriculture to try out resistant or immune varieties. From the successive increase of the few short pieces of P. O. J. 234 which Elliott Jones, field manager of Southdown plantation, Houma, La., carried to Louisiana from the Washington greenhouse in April, 1922, approximately 20,000 acres will have been planted in 1927. This variety, together with P. O. J. 36 and 213 obtained the following year, showed such promise in the Southdown tests that in 1924 the department recommended all three varieties for general trial in the State.

[1] Acknowledgment is made to G. B. Sartoris, associate pathologist, Office of Sugar Plants, for cooperation in certain phases of the work.
[2] Italic figures in parentheses refer to literature cited, p. 19.

A comparison of the yields of the old varieties during the last three calamitous years with the favorable performance of the new varieties demonstrates the wisdom of that step and apparently assures a rehabilitation of the industry as soon as the entire acreage can be substituted. However, from the beginning it was recognized that these new canes possess certain serious disadvantages, which it is hoped to remedy either by new importations or by systematic cane breeding in the United States. Collections of additional promising foreign varieties have been imported, therefore, and in 1921 a breeding station was established at Canal Point in southern Florida for developing canes better adapted to conditions in Louisiana and other Southern States.

This report gives preliminary data on a number of the imported varieties which had been increased sufficiently to be included in comparative plot tests during the crop year 1925–26. Since the number and productiveness of successive stubble crops determine largely the value of a variety in Louisiana, final judgment must obviously await the results of several years' study of these canes, whose chief merit in other countries has been their long ratooning record. With this in mind, therefore, the data here presented, obtained on plant cane only during a most unusual season, can be better interpreted. It seems appropriate to preface this initial report with a brief outline of the aims and methods of the department in the comprehensive varietal testing project lately inaugurated in Louisiana in cooperation with the State agricultural experiment station.

THE VARIETAL TESTING PROJECT

The new seedling canes produced at the Florida station and the imported varieties (the latter after passing successfully the required quarantine period in Washington greenhouses) are sent to the department's field station on Southdown plantation near Houma, La., and to the State station at Baton Rouge, La., where studies of their local adaptability and possible commercial value begin. While the seed-cane supply is being increased at these stations, the canes are successively grown in small nursery plantings, row or "line" tests, plot experiments, and finally in large cooperative plantation trials. Owing to various disadvantages, naturally a large proportion of the canes have to be discarded at one step or another during this process. Thus the general program, including careful study of the agricultural and chemical characteristics of the varieties, conforms closely with standardized procedure for such work in a number of other sugar-cane countries. While unfortunately slow, costly, and tedious, this method appears to be the best thus far developed for improving sugar-cane yields through varietal substitution. With increased knowledge of inheritance in the sugar cane, not only of the outward plant characters but of such chemical and physiological factors as sucrose content and disease resistance, much saving of time and expense may be effected.

Unfortunately, through lack of funds and proper facilities at the Florida station, hybridizing work and seedling production have only lately attained adequate proportions, so that up to 1926 only the earlier imported varieties had been increased to the stage of plot tests in Louisiana.

EXPERIMENTAL METHODS

PLOT TECHNIC

In undertaking to determine in as short a time as possible the best yielders among such a collection of varieties as is now represented at the Louisiana stations, special methods are necessary. In the first place, it is well to remember that there is no such thing as an absolute yield of any variety. The best that can be hoped for is a series of measurements so conducted that the average will be a convenient expression for the performance of that variety. In order to obtain quickly such a representative average for the different types of soil and the varieties best suited to each, it is essential that the same varieties be tested in as many representative localities and soils as possible and that the varieties be so arranged as to give the best possible comparison in each test. To accomplish this end, 10 well-chosen "substations" or cooperative plantation test fields have been established thus far in Louisiana by State and Federal workers. Such widespread distribution of the tests is naturally very important, because it gives a better idea of the performance which might be expected in extensive culture. In other words, if expense and time are much limited for such work it is better to conduct many well-scattered, less accurate tests than only a few less representative ones having a high degree of accuracy. A desirable combination of the two methods is attained in Java, for example, where new varieties are at first widely scattered and compared in small so-called "orientation" tests, and if at the end of the first year they show promise they are then compared in fairly widespread, carefully controlled and replicated plot experiments.

Proper arrangement of the individual plot tests greatly increases the reliability of the comparison without much increase in cost. It must be recognized that the difference in yield obtained between any two varieties in the experiment may be due to a number of factors, any one of which might have been partly or wholly responsible for the result: (1) Possible inherent differences in yielding capacity of the varieties tested; (2) differences in soil, fertility, drainage, etc., between the areas where the two varieties are grown (systematic errors); and (3) differences in stand, cultivation, harvesting, borer damage, and all other circumstances of an accidental nature (accidental errors). Therefore, to be sure that the apparently superior yield obtained from one variety is mainly owing to the variety itself and not largely to these other circumstances (2 and 3), it is essential to exercise great care in all the operations and to arrange the varieties so as to reduce these errors as much as possible. Even with the greatest precautions and elaborate arrangement, the variations will still be so large as to prohibit consideration of the smaller differences in the varieties, which, if real, would be none the less economically significant.

The general principles of variety testing have been discussed in a previous paper (*8*), in which the attempt was made to show that in order to get fairly reliable results each variety comparison should be confined to a relatively small area, thus eliminating important differences in yield due to wide variations in soil, and it was suggested that 6 to 10 plots of the smallest practicable size of each variety be planted, the plots being distributed in checkerboard fashion over

the entire area. The average yield of each series, together with the measured variations, permits the application of statistical interpretations and an expression of the degree of confidence that may be placed in the results. In a comparatively short time, therefore, the less productive canes can be discarded. In the limited scope of this circular it is unnecessary to go into a discussion of the various methods and mathematical formulas adapted for this purpose.

The planting plan of the variety test on the P. R. Landry plantation near Lafayette, La., (fig. 2) illustrates the arrangement of plots here referred to. Unfortunately, there was insufficient seed of two of the P. O. J. canes to make the same number of replications of all varieties, therefore the extra plots were filled out with native cane.

METHODS OF SAMPLING, ANALYSIS, AND CALCULATION

SAMPLING

Single samples of from 3 to 5 stalks each were taken at weekly intervals during a month or more preceding harvest to determine the approximate rate of ripening of the varieties. Immediately after the experiments were harvested, 6 representative 5-stalk samples were selected at random from the piles of cane of each variety, 4 for the laboratory mill and 2 for the shredder. Although the cooperating factory chemist has often assisted with the preliminary analyses, the harvest samples have thus far been handled exclusively at the Houma station laboratory. The cane was passed through the small three-roller laboratory mill (motor driven), the bagasse doubled and passed through again, and the two juices combined and mixed. Juice extraction averaged 60.3 per cent in the case of 9 samples of P. O. J. varieties and 62.9 per cent for 2 samples of Louisiana Purple.

The shredder samples were used for direct determination of the sucrose (polarization) and fiber in the cane. The sample of cane was reduced to an extremely fine state of division by means of a small shredding machine, identical with the Hyatt cane reducer described by Spencer (*9, p. 214-215*), operated at a speed of 1,200 revolutions per minute.

In the large mill test here reported an adequate composite sample of 3 to 4 tons, representing each plot or section of the field, was used. The samples of factory mill juice were obtained by taking a small can of juice at about one-minute intervals throughout the milling of each variety; the entire quantity collected was mixed, and aliquot samples were preserved by adding mercuric chloride and were taken to the Houma station laboratory for analysis.

ANALYSES

All analyses were made at the Houma station laboratory.

The accuracy of the saccharimeter, Brix hydrometers, etc., had been certified by the United States Bureau of Standards, and the accuracy of the former was frequently checked by standard quartz plates.

Juice samples were either analyzed at once or, as in the case of the mill test at the Billeaud factory, were preserved immediately by adding mercuric chloride and were analyzed the following morning.

Reducing sugars ("glucose") were determined by means of Violette's method.

In the case of the direct determination of sucrose (polarization) and fiber in the cane, 100-gram samples of the thoroughly mixed shredded cane were placed in digesters similar to the one described by Norris (*6, p. 11*) for the digestion of bagasse; approximately 200 cubic centimeters of boiling water plus 5 cubic centimeters of 5 per cent sodium-carbonate solution was added and the digester was placed in a boiling water bath for 10 minutes, during which time the mass was agitated several times. The extract was poured off, and as much as possible of the residual extract was removed by subjecting the mass to pressure. Extraction was repeated six times in a similar manner, except that no sodium carbonate was added. The combined extract was cooled and weighed, a representative portion was clarified with Horne's dry lead subacetate and polarized, and the percentage of sucrose was calculated by means of the Schmitz-Horne table. This procedure afforded a practically complete extraction of the water-soluble material, but the low sucrose in the cane, together with the large volume of combined extract, resulted in such small polarization figures that the results for polarization on cane can not be considered as accurate but merely as a basis for approximation.

The exhausted material was spread in shallow pans, dried at 110° to 120° C. to constant weight, and this weight used as the percentage of fiber in the cane.

CALCULATION

The Winter-Carp (Java) formula (*7, p. 439–440*) was used for the calculation of "available" sugar. Referring to the discussion by Geerligs (*5*) of the development of available sugar formulas, it appears that the Winter-Carp formula affords results in terms of "refining crystals" of about 96.5 polarization. Spencer (*9, p. 306–307*) states, however, that the results must be divided by 0.96 in order to obtain results in terms of 96° sugar. In view of the remarkably close agreement of typical calculated and actual figures, as given by Spencer, it appears that the formula plus the divisor 0.96 affords very reliable figures. The formula used in the present work is:

$$\frac{S\times(1.4-\frac{40}{P})}{0.96}$$

S=Sucrose extracted per cent cane; equivalent to per cent mixed juice extracted × per cent sucrose (polarization) in mixed juice.

P=Purity of mixed juice.

N. B.—All results have been stated on a boiling house efficiency of 100 per cent.

For the calculation of "available" sugar from laboratory mill-juice analyses it has been assumed that the composition of these juices (60 per cent extraction) will correspond to the composition of crusher juice from factory mills. "Reduction factors" for converting polarization and Brix of crusher juice to polarization and Brix of mixed juice, calculated from the analyses of the juices obtained from the Billeaud factory test—the only data thus far available (see Table 7)—are shown in Table 1.

TABLE 1.—*"Reduction" factors for converting polarization and Brix of crusher juice to polarization and Brix of mixed juice. (Based on 1926 data only)*

Variety	Factor for polarization	Factor for Brix
Louisiana Purple	0.946	0.954
P. O. J. 36	.913	.958
P. O. J. 213	.891	.946
P. O. J. 234	.910	.951
P. O. J. 826	.940	.963
Average	.920	.954

The average reduction factors were used for converting polarization and Brix of laboratory mill juice to probable polarization and Brix of mixed juice, and this polarization and Brix were used for obtaining purity of mixed juice. "Available" sugar was then calculated by means of the above-mentioned Winter-Carp formula, this calculated polarization and purity being used and it being assumed in all cases that a 78 per cent juice extraction had been obtained. The factors involved are subject to change, depending upon the accumulation of more data relative to the milling of P. O. J. varieties in Louisiana; but it is believed that the method used affords a fair approximation of available sugar, and undoubtedly the results are comparable.

VARIETIES TESTED IN 1926

All the imported varieties included in the plot tests in 1926 originated in Java and bear the designation P. O. J., the initials of the earlier name of the planters' experiment station at Pasoeroean, Java, "Proefstation Oost Java." More lately, since other stations have been consolidated with it, this station has been known as the Experiment Station for the Java Sugar Industry. However, the designation P. O. J. has been retained for all seedlings developed by the station. Through the kindness of the officials of this station, the United States Department of Agriculture has obtained cuttings of practically all of these seedlings which from their parentage, disease resistance, and general characteristics appeared to have commercial possibilities for Louisiana. Several of the varieties in the partial list given in Table 2 came to the United States by direct importation from Java or indirectly through other countries, while others were selected from the Java station fields by E. W. Brandes during a trip to the Orient in 1922.

While several of the early P. O. J. varieties have proved to be of great value in cane regions such as Egypt, Formosa, Argentina, Porto Rico, and Louisiana, curiously enough they appear never to have occupied more than an infinitesimal proportion of the Java cane acreage. This situation is, of course, due to conditions and practices peculiar to that country, as, for example, the absence of cold, to which some of these varieties are somewhat tolerant; the absence of ratooning crops, for which they are highly regarded in other countries; and a cheap labor supply, making the selection and roguing of disease-

susceptible varieties more economical than substituting these resistant but lower sugar-yielding seedlings.

Extended comparison during the last three years on representative sugar-belt soils has shown that the varieties here listed (Table 2) are more or less tolerant or immune to mosaic and especially to the root-disease complex, which latter is an important cause of the greatly reduced yields and frequent failures of stubble crops in Louisana. The disease resistance of the earlier numbers of the P. O. J. series comes from their paternal parent, the Chunnee of northern India, while that of the "27 series" (numbered 2700 to 2799) is derived from Glagah (*Saccharum spontaneum*), a wild sugar cane of eastern Asia. The latter type is characterized by a very low sucrose content but pronounced resistance or immunity to most of the world's destructive sugar-cane diseases. Through successive crosses with high sugar-yielding but susceptible varieties the Java cane breeders have finally combined in the "27" and succeeding series a good measure of the

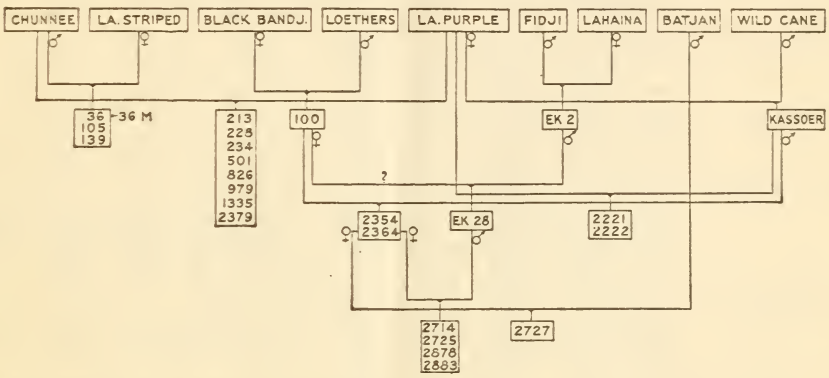

FIG. 1.—Relation and parentage of some P. O. J. varieties of sugar cane. The upper horizontal row gives exclusively the so-called original varieties earlier cultivated in Java and elsewhere. The arrangement of the seedlings is purely arbitrary for convenience of reference. The signs ♂ (male) and ♀ (female) indicate which of the two parents was used as mother and which as father in the various crosses

vigor and resistance of the wild cane with the fine qualities of the "noble" varieties. A detailed description of the various hybrids and their reaction to disease has been published by Brandes and Klaphaak (*4*).

Figure 1, adapted from a similar diagram in Bannier's (*1*) recent paper on cane breeding, illustrates graphically the relationship of all the varieties here discussed.

In Table 2 are listed some analyses of the laboratory mill juice of several P. O. J. canes made in the brief period during which they have been grown at Houma, La. These may help to interpret the 1926 results, although it will be remembered that 1925 had even lower sucroses and purities, owing to heavy borer infestation, high temperatures, and almost continuous rains throughout the normal ripening period, and not to an interruption in growth as resulted from the hurricane in 1926. Therefore, for the Houma section it is believed the analyses of 1924, although made on late spring-planted cane, are more nearly typical of an average season.

TABLE 2.—*Analyses of laboratory mill juice and determinations of fiber of P. O. J. varieties compared with D–74 sugar cane at Houma, La.*[1]

Variety[2]	Year	Plant cane					First stubble			
		Date	Brix	Polarization	Purity	Fiber (per cent)	Date	Brix	Polarization	Purity
D–74 (check)	1924	Nov. 7	13.92	9.74	70.0		Nov. 2	14.14	9.62	68.1
		Nov. 20	14.55	11.26	77.4		Nov. 7	14.51	10.60	73.1
	1925	Nov. 9	13.90	10.00	71.9					
		Nov. 20	14.05	10.40	74.0	7.5				
	1926	Oct. 22	13.40	9.50	70.9		Oct. 23	12.90	9.00	69.8
		Oct. 27	14.55	10.50	72.2	9.6	Oct. 26	13.20	9.15	69.3
P. O. J. 36	1924	Nov. 8	13.61	9.25	67.96					
		Nov. 14	14.78	11.19	75.71					
	1925	Nov. 20	12.60	8.10	64.3	11.8	Oct. 30	10.70	6.20	58.0
	1926	Nov. 4	12.61	8.73	69.2		Oct. 23	12.35	8.70	70.4
		Nov. 13	11.85	7.40	62.4	14.4	Nov. 15	15.30	8.20	53.6
P. O. J. 36–M	1924	Nov. 14	14.54	11.38	78.27					
		Nov. 26	15.02	12.54	83.49					
	1925	Nov. 9	11.80	7.60	64.4		Oct. 28	12.90	9.00	69.8
		Nov. 20	13.10	9.70	74.0	12.4	Nov. 10	13.30	9.40	70.7
	1926	Oct. 21	10.45	6.40	61.2		Oct. 26	15.40	12.20	79.2
		Nov. 4	13.29	9.40	70.7	13.3				
P. O. J. 213	1924	Nov. 26	14.72	11.81	80.23					
	1925	Nov. 10	13.35	9.60	71.9		Oct. 30	11.35	7.00	61.7
		Nov. 20	14.50	11.30	77.9	11.3				
	1926	Nov. 5	13.23	9.68	73.2		Oct. 23	13.40	9.90	73.9
		Nov. 13	13.60	10.10	74.3	13.1	Nov. 15	15.25	11.30	74.1
P. O. J. 228	1924	Nov. 14	13.79	9.92	71.13					
	1925	Oct. 29	11.65	7.10	60.9		Oct. 28	11.75	7.35	62.6
		Nov. 20	12.85	8.40	65.4	11.2	Nov. 10	12.70	8.30	65.4
	1926	Oct. 23	11.50	7.10	61.7		Oct. 26	12.65	8.60	68.0
		Nov. 4	12.41	8.23	66.4	12.5				
P. O. J. 234	1924	Nov. 21	15.64	12.27	78.45		Nov. 21	14.83	11.99	80.85
		Nov. 26	14.37	12.01	83.58		Nov. 26	15.38	12.40	80.62
	1925	Nov. 10	13.15	8.90	67.7		Oct. 29	14.05	10.90	77.60
		Nov. 20	13.60	9.60	70.6	11.7	Nov. 24	15.85	13.00	82.0
	1926	Oct. 27	13.80	9.80	71.0		Oct. 23	12.25	8.10	66.1
		Nov. 13	13.00	9.10	70.0	14.5	Nov. 15	14.05	10.40	74.0
P. O. J. 826	1924	Nov. 14	13.67	9.49	69.42					
		Nov. 18	14.39	11.19	77.76					
	1925	Nov. 20	13.05	8.50	65.1		Nov. 24	12.90	8.80	68.2
	1926	Nov. 5	12.91	8.63	66.9	11.8	Oct. 26	12.15	8.10	66.7
P. O. J. 979	1924	Nov. 14	14.73	11.37	77.18					
		Nov. 18	13.86	9.72	70.13					
	1925	Nov. 9	11.85	7.40	62.4		Oct. 28	11.60	6.70	57.8
		Nov. 20	12.10	7.40	61.2		Nov. 10	11.75	7.00	59.6
	1926	Oct. 22	14.15	9.75	68.9		Oct. 25	12.95	8.70	67.2
		Nov. 5	13.78	8.95	64.9	11.8				
P. O. J. 1228	1925	Oct. 29	10.60	6.20	58.5		Oct. 28	11.40	6.80	59.6
		Nov. 20	11.85	7.50	63.3		Nov. 10	11.60	7.10	61.2
	1926						Oct. 26	12.05	7.75	64.3
P. O. J. 2379	1925	Nov. 9	12.90	7.90	61.2					
		Nov. 20	12.50	7.90	63.2	9.8				
	1926	Oct. 22	13.55	8.70	64.2		Oct. 26	13.60	9.30	68.4
		Nov. 5	13.11	8.91	68.0	12.6				
P. O. J. 2714	1924	Nov. 8	12.53	7.46	59.53					
	1925	Nov. 9	10.65	5.50	51.6		Oct. 28	11.20	6.50	58.0
		Nov. 20	11.70	6.50	55.6		Nov. 10	11.70	6.70	57.3
	1926	Oct. 22	11.40	6.60	57.9		Oct. 26	11.60	6.90	59.5
		Nov. 5	11.88	7.20	60.5	12.5				
P. O. J. 2725	1924	Nov. 18	14.29	10.26	71.79					
		Nov. 26	14.23	10.80	75.90					
	1925	Nov. 9	12.90	8.60	66.70		Oct. 28	11.80	7.15	60.6
		Nov. 20	14.25	10.20	71.6	8.6	Nov. 10	13.70	9.40	68.6
	1926	Oct. 22	11.00	6.60	60.0		Oct. 26	13.55	9.40	69.4
		Nov. 5	12.33	7.55	61.4	11.7				
P. O. J. 2727	1924	Nov. 14	13.52	8.94	66.12					
		Nov. 18	14.29	9.82	68.72					
	1925	Nov. 9	13.30	9.00	67.7		Oct. 28	12.40	7.50	60.5
		Nov. 20	15.05	10.90	72.4	10.5	Nov. 10	12.55	7.70	61.4
	1926	Oct. 22	11.90	7.10	59.7		Oct. 26	12.10	7.45	61.6
		Nov. 5	12.65	7.80	61.6	11.8				

[1] Most of these analyses are based on a single sample consisting of two to five stalks taken from individual stools or small nursery rows and afford merely an indication of the comparative performance.

[2] The P. O. J. 36, 213, 228, and 234 were first received in August, 1919, from the experiment station at Tucuman, Argentina, and planted in quarantine at Collins Key, Miami, Fla. All but No. 234 developed mosaic and were destroyed by the Federal Horticultural Board. They were again imported in August, 1921, along with P. O. J. 826, 979, 1228, and 2379 from the sugar experiment station at Pasoerbean, Java. The remaining numbers, P. O. J. 36–M, 2714, 2725, and 2727, were obtained from the experiment station at Shinka, Formosa.

UNFAVORABLE WEATHER OF 1926

The crop year 1925–26 was unfavorable for cane growth owing to the wet winter, cold, late spring, and a destructive hurricane in August. At the Government field station on Southdown plantation near Houma, La., where most of these tests were conducted, the storm of August 25 not only completely prostrated and broke many stalks of some varieties, but caused in all a temporary cessation of growth and an unquestionably large though undetermined reduction in cane yield. Its indirect depressing effect on subsequent sucrose content and purity of juice is another unknown factor influencing the final results. However, as hurricanes are a certain though infrequent hazard to the Louisiana sugar industry, this one provided opportunity for obtaining valuable data on the relative storm endurance of the different varieties, growing as they were in small checkerboard plots of equal size and exposure. While the detailed data will be reserved for a later report, suffice it to say now that the three varieties, P. O. J. 36, 213, and 234, thus far recommended by the department, suffered very little breakage compared with the adjacent fields of D–74. Apparently, such was also the case in other sections of the storm area wherever these canes had been planted. They were, of course, blown flat to the ground, but they quickly erected themselves and replaced the shredded dying leaves by new growth. This setback, combined with unseasonably warm and moist weather in September and October, undoubtedly resulted in lower sucrose and purity figures than might otherwise have been the case.

In the Lafayette district, where a cooperative variety test was conducted, the weather conditions were quite different. The season opened with a cold, wet March with about 12 inches of rainfall, followed by drought in July and protracted dry weather in September and October, the latter condition being confined to a small area immediately surrounding the test. Cane yields consequently were much reduced. Notes made October 7 on relative drought resistance, judged solely by the extent of yellowing of the leaves, showed P. O. J. 213 to be the greenest, while P. O. J. 234, Louisiana Purple, and P. O. J. 36 and 826 were progressively bleached in the order named, the variety last mentioned being decidedly yellow. However, after the first rain, on October 12, all greened up again, and growth was resumed.

TESTS NEAR HOUMA, LA.[3]

At the department's field station on the Southdown plantation near Houma, La., varietal comparisons were made with plantings partially in duplicate on two typical Louisiana Delta soils: (1) Moderately light "front bayou land" and (2) heavy, sticky, black clay, or "buckshot" soil. The first, with its lighter and heavier phases, has been estimated to represent 40 per cent, and the second, together with the mixed lands, 60 per cent of the Louisiana sugar belt. The station fields are known to have produced sugar cane more or less continuously under the regular three-year or other rotation schemes during the last 96 years. A stubble crop of D–74 severely affected by mosaic and root rot, the latter more especially in the heavy soil, had been

[3] Acknowledgment is made to the managers of Southdown plantation for their continued cooperation and the whole-hearted fulfillment of their agreement regarding the field work of the station.

harvested in November, 1924. The old stubbles were broken out, and the land was sown to sour clover, followed during the summer of 1925 by Biloxi soy beans. These were plowed under, and no other fertilizer was used. The ditches were deepened, and the land was given deep and thorough preparation, but the nearly incessant rains in the fall of 1925 delayed planting until November 16 to 20.

TABLE 3.—*Results of test of sugar-cane varieties (plant cane) on light and heavy soils on Southdown plantation, Houma, La., 1925–26*

Soil and variety of cane	Acre yield of cane (tons of 2,000 lbs.)							
	First plot	Second plot	Third plot	Fourth plot	Fifth plot	Sixth plot	Seventh plot	Average
On light soil:								
P. O. J. 36	19.0	16.4	20.2	16.3	17.0	19.0	----------	17.98
P. O. J. 213	23.6	15.3	24.1	22.6	23.6	25.8	----------	22.50
P. O. J. 234	24.7	16.2	25.4	22.5	22.5	----------	----------	22.26
P. O. J. 826 [1]	18.1	20.7	20.1	----------	----------	----------	----------	19.63
On heavy soil:								
P. O. J. 36	19.9	18.6	22.2	21.9	23.1	21.9	22.3	21.42
P. O. J. 213	20.6	22.3	22.2	23.5	25.2	24.3	23.5	23.09
P. O. J. 234	20.7	19.2	18.4	24.3	24.8	26.5	20.5	22.66
P. O. J. 826 [1]	----------	----------	----------	22.3	20.4	23.0	19.0	21.18

Soil and variety of cane	Sucrose in cane [2]			Fiber in cane [2] (per cent)	Laboratory mill juice analyses			Available 96° sugar [3]		Tons cane for 1 ton sugar [4]
	Per cent	Pounds per ton	Pounds per acre		Brix	Polarization	Purity	Pounds per ton of cane	Pounds per acre	
On light soil:										
P. O. J. 36	6.16	123.2	2,218	14.4	12.61	8.73	69.2	104.4	1,877	19.2
P. O. J. 213	6.92	138.4	3,114	13.1	12.61	8.94	70.9	108.8	2,448	18.4
P. O. J. 234	8.24	164.8	3,675	14.5	13.28	9.44	71.3	115.2	2,564	17.4
P. O. J. 826 [1]	----------	----------	----------	----------	11.91	7.50	63.0	83.2	1,633	24.0
On heavy soil:										
P. O. J. 36	6.65	133.0	2,849	11.9	12.35	8.28	67.0	96.7	2,071	20.7
P. O. J. 213	8.48	169.6	3,914	13.1	13.96	10.73	76.8	138.0	3,186	14.5
P. O. J. 234	7.13	142.6	3,155	13.7	13.71	9.81	72.4	120.3	2,654	16.6
P. O. J 826 [1]	6.77	135.4	2,868	10.6	12.39	8.00	64.6	90.6	1.919	22.1

[1] Spring planted (Mar. 1–3, 1926).
[2] By direct analysis on shredded cane.
[3] Winter-Carp (Java) formula, and polarization and purity of mixed juice (dry milling), as calculated from polarization and Brix of laboratory mill juice, assuming 78 per cent juice extraction and a boiling-house efficiency of 100.
[4] Tons of 2,000 pounds.

The varieties were planted in three-row units or plots one-fortieth of an acre in area, replicated and distributed in checkerboard fashion as already outlined. Enough seed cane was available from the station nursery rows to plant a light-soil test of three plots each of P. O. J. 36–M, 228, 979, 2379, 2714, 2725, and 2727, while seed of P. O. J. 36, 213, and 234, kindly supplied by Southdown plantation, was extended to 6 to 8 plots each on the light soil, and a similar number of plots were put in a separate test on black land. Both tests were supplemented in the spring (March 1 to 3) with P. O. J. 826 seed obtained from the Government sirup station at Cairo, Ga.

The severely bored condition of the station seed necessitated planting 1½ to 2 running stalks in the case of the P. O. J. varieties and 3 to 4 running stalks of D–74, which was used as a standard. The

Southdown seed, coming from larger areas and apparently having been less of a mark for the borers, was much less damaged, and all these plots and those of D–74 gave fairly uniform stands. All the others were very irregular and gappy, as seemingly it was impossible to judge the undermining of "eyes" by superficial inspection of the seed cane. Consequently, portions of each plot came up with twice the necessary number of plants, while other portions failed entirely. The borer-free P. O. J. 826 seed planted in the spring at the rate of slightly less than one stalk gave perfect stands.

TABLE 4.—*Comparative differences in yields of sugar-cane varieties on light and heavy soils in test on Southdown plantation, Houma, La., 1925–26*

Variety compared with those in column headings at right	Increase (+) or decrease (−) in acre yield of cane and available sugar of varieties listed in first column as compared with those in column headings below			
	P. O. J. 36		P. O. J. 213	
	Cane (tons[1])	Sugar (lbs.)	Cane (tons[1])	Sugar (lbs.)
On light soil:				
P. O. J. 36			−4.52±1.12	−571±119
P. O. J. 213	+4.52±1.12	+571±119		
P. O. J. 234	+4.28±1.19	+687±130	−0.24±1.19	+116±132
P. O. J. 826	+1.65±1.48	−244±132	−2.87±1.48	−815±135
	P. O. J. 234		P. O. J. 826	
P. O. J. 36	−4.28±1.19	−687±130	−1.65±1.48	+244±132
P. O. J. 213	+0.24±1.19	−116±132	+2.87±1.48	+815±135
P. O. J. 234			+2.63±1.54	+931±145
P. O. J. 826	−2.63±1.54	−931±145		
	P. O. J. 36		P. O. J. 213	
On heavy soil:				
P. O. J. 36			−1.67±0.77	−1,115±91
P. O. J. 213	+1.67±0.77	+1,115±91		
P. O. J. 234	+0.64±0.77	+583±83	−1.03±0.77	−532±99
P. O. J. 826	−0.24±0.94	−152±87	−1.91±0.94	−1,267±103
	P. O J. 234		P. O. J. 826	
P. O. J. 36	−0.64±0.77	−583±83	+0.24±0.94	+152±87
P. O. J. 213	+1.03±0.77	+532±99	+1.91±0.94	+1,267±103
P. O. J. 234			+0.88±0.94	+735±96
P. O. J. 826	−0.88±0.94	−735±96		

[1] Tons of 2,000 pounds.

The experimental or probable error for the average yield (mean) of any variety was determined by dividing the average standard deviation for the experiment by $\sqrt{n-1}$, when n equals the number of replications of that variety, and multiplying by 0.6745. The probable error of the difference between the average yields of any two varieties then was calculated as the square root of the sum of the squares of the probable errors of the means. This takes no account of any possible correlated variation. The correct probable errors of the differences, therefore, probably would be somewhat smaller, as there is some evidence, as for example in the heavy-soil test, that certain areas tended to be more productive than others with probability of similar influence on the different varieties.

Notes taken March 30 give some indication of the relative earliness of the varieties. P. O. J. 234 was the most advanced, having plants uniformly 4 to 6 inches high; 213 and 228 were fairly marking the row 2 to 4 inches high; 36, 36–M, and 2727 had scattering plants of

irregular height in all plots, while the remainder were still dormant. All the varieties made good early-season growth, but, as has already been mentioned, they were much retarded and reduced in yield by the hurricane of August 25. A late-season borer infestation on the light land doubtless accentuated this in such canes as P. O. J. 213 and the 27 series, but on the black land, a quarter of a mile back, practically no damage occurred.

Both sets of test plots were harvested November 1 to 3, somewhat earlier than is customary for plant cane, in order not to jeopardize the value of the crop for seed purposes. The results are presented in Tables 3 and 4, which, it will be noted, include only the four varieties having uniform stands, viz, P. O. J. 36, 213, 234, and 826. In the plot arrangement these varieties were usually directly adjacent to one another, making direct comparison within a series or replication more reliable than between replications which were often separated by other varieties.

The D–74, used as the standard, was unfortunately so broken by the hurricane as to be worthless for comparative purposes. It had not been included in the black-land experiment for the obvious reason that on such difficult soils it had repeatedly failed in the past, and the intention was to compare only the more vigorous P. O. J. canes. Of the latter, the 826 is, of course, not strictly comparable, having been planted in the spring. Therefore, through an unfortunate combination of adverse circumstances, the station tests for 1926 leave much to be desired.

The average tonnage yields of cane per acre shown in Table 3 are disappointingly below all expectations based on the general performance of the first three varieties during the two previous years that they had been observed on Southdown plantation. However, as has already been explained, this is probably accounted for largely by the unfavorable seasonal conditions, especially the hurricane. The same factors, combined with early harvesting (November 1 to 3), doubtless also depressed the sucrose and purity figures of juices and caused the abnormally high cane-to-sugar ratios shown in the last column of Table 3. The similar tonnage yields of the varieties on soil of two such widely different types, and especially the favorable outcome of the black-land test, indicate the wide adaptability of these hardy canes to Louisiana conditions.

As regards possible differences in yielding capacity of the varieties, any conclusions applicable to the sugar belt as a whole would, of course, be unwarranted. Even for the immediate locality of the tests not much can be said on the basis of one year's results on plant cane alone during such an unusual season. Since more extended comparative plots including these same varieties have now been planted in a dozen or more widely separated localities, accurate results of widespread applicability should soon be forthcoming. However, as no two seasons are alike, it seems worth while to call attention to certain significant differences in the present tests brought out in Table 4, without, of course, implying that such differences would necessarily occur during a more normal season. Inasmuch as no difference less than three times its experimental error is considered significant, it will be noted that the two varieties, P. O. J. 36 and 826, on either soil

gave about the same acre yields of cane and available sugar; that on the light soil P. O. J. 213 and P. O. J. 234 produced at least 3 tons more cane and 400 to 500 pounds more sugar per acre than the other two varieties; and that on the heavy soil, although no such difference in cane is found, nevertheless, owing to richer juices, similar or larger sugar yields were produced. Mainly for the same reason, P. O. J. 213 on heavy soil produced several hundred pounds more sugar than P. O. J. 234. However, this may be only a seasonal effect (possibly quicker recuperation from the hurricane), since 234 is generally considered the earlier variety of the two. On the other hand, in spite of much greater borer damage, the yields of 213 on the light soil were equal to those of 234. As a whole, therefore, these preliminary results indicate that for this particular season and locality P. O. J. 213 and 234 as plant cane were much superior to P. O. J. 36 and 826. This conclusion can be somewhat modified, however, as to the results on soil of a widely different type summarized in the following pages.

TESTS NEAR LAFAYETTE, LA.

The rather extensive sugar-cane area west of New Iberia, La., comprising gently undulating lands with better subsoil drainage, represents a distinct change in the type of soil and productive capacity from the more typical "bayou" soils of the Mississippi Delta. Also, as was indicated by a comprehensive survey conducted for several years by the United States Department of Agriculture (*3*), this section was the last to be invaded by mosaic, and therefore it has not suffered from declining yields to the same extent as have other parts of the sugar belt. The excellent natural s il drainage hastens the ripening processes of the cane during the usual dry periods in October and November, and generally much higher yields of sugar per ton of cane are obtained. For this reason it is evident that promising new varieties which fail to meet commercial requirements during wet years in the river and bayou sections may possibly produce satisfactory sugar yields here. Hence arrangements were made for the carrying out of a cooperative variety test on the plantation of P. R. Landry,[4] near Lafayette, La.

The same varieties tested most extensively at Houma (P. O. J. 36, 213, 234, and 826) were included in the tests on the Landry plantation. The seed cane was shipped from Cairo, Ga., late in February and was planted March 8, 1926—one to two weeks later than most of the 1926 plantings in that section. Locally grown seed of Louisiana Purple of average quality was planted for the control. Although better yields would doubtless have been obtained if fertilizer had been used, none was used because of the possibility that it would influence the different varieties unequally. The field used for the plantings had produced in 1925 a crop of cotton to which had been applied 200 pounds of acid phosphate and 100 pounds of nitrate of soda per acre. In 1923 and 1924 it had produced cane, and in the two preceding

[4] Acknowledgment is made to Mr. Landry for his cordial cooperation and for the donation of 80 per cent of the tonnage produced to insure an adequate large-mill test of the varieties. Similar acknowledgment is made to the Billeaud Sugar Co. for the use of its mill for the test.

years corn and cowpeas, the latter being used for hay. Both the soil and its crop history, therefore, are fairly representative of this section, in which a longer rotation is commonly practiced.

An area covering approximately 2⅖ acres was prepared for planting and staked off into approximately eighteenth-acre plots (16½ by 145 feet) and planted in the usual way, according to the scheme shown in Figure 2. Enough seed was available for eight replications of P. O. J. 213 and 234 and for but six of P. O. J. 36 and 826, including two half plots. The remaining plots were filled out with Louisiana Purple.

Unfavorable spring weather, already described, somewhat delayed germination, but eventually fairly uniform stands came up in all

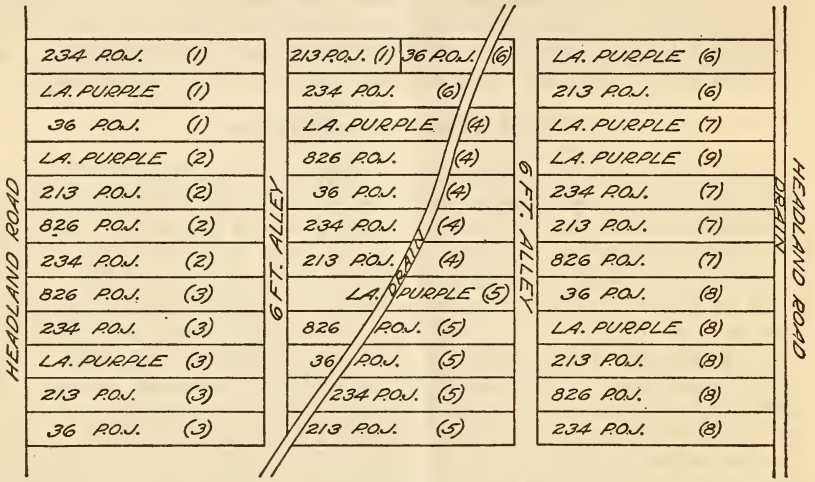

FIG. 2.—Planting plan of the cooperative sugar-cane variety test on the Landry plantation, Lafayette, La., showing replication groups (numbers in parentheses) and plots compared in Table 5. Each plot consists of three rows 5½ feet apart and 145 feet long

plots. Counts of the total number of mother or seed shoots in several representative plots of each variety in advance of much suckering showed that P. O. J. 213 had the thinnest stands, namely, an average of one plant about every 2 to 2½ feet, which is possibly under optimum. As at Houma, P. O. J. 234 germinated and started suckering ahead of any other variety, but 826, according to Mr. Landry, soon passed it and became the most conspicuous variety in the test. This advantage was merely temporary, however, and was due to the habit of 826 of forming large mother plants before beginning to sucker.

With the usual field cultivation and weedings the plants continued to grow well through July and August, but, as has been previously mentioned, severe drought in September and October greatly curtailed the yields. A late borer infestation doubtless also contributed to the latter result, especially in the case of P. O. J. 213, which seemed to attract the borer moths more than did any other variety. An inspec-

tion of the field in October showed the Louisiana Purple to be much thinner in the row than the other varieties. By some visitors this was erroneously interpreted to mean a thinner stand, which was not the case, as this appearance was due to the naturally heavier stooling of the more vigorous P. O. J. canes.

The experimental cane was harvested and weighed November 8 to 10, somewhat earlier than the average date for plant cane in this section, and the large-mill test was conducted at the Billeaud factory November 11, 1926. In ease of stripping, Mr. Landry ranked the varieties as follows: Louisiana Purple (easiest), P. O. J. 36, 826, 234, and 213, the 826 and 234 being nearly the same. From one or more piles of cane in each plot, stalks were selected at random until six samples of five stalks each had been obtained from each variety. These were transported to the Houma laboratory for chemical analysis and fiber determinations. The complete results of the experiment and mill test are summarized in Tables 5, 6, 7, and 8.

In noting the differences between the varieties in yield of cane and sugar, shown in Table 8, account should be taken of several unknown factors which may or may not have influenced the varieties to the same degree and are therefore not measured in the probability computations, viz: (1) The effect of the different seed sources and possible injury to the P. O. J. seed cane from drying during nearly two weeks in transit; (2) the possible unequal retarding effect of the drought on the different varieties.

Bearing in mind these points and the further fact that the comparisons are limited to results from plant cane only, the writers consider the following tentative conclusions warranted by the experiment on the Landry plantation.

Inasmuch as no difference less than three times its experimental error is deemed significant, it will be noted that each of the P. O. J. varieties exceeded the Louisiana Purple in yield by 2 to 3 tons of cane per acre. However, in sugar yield, P. O. J. 213 and 234 only are significantly higher, giving, respectively, about 300 and 800 pounds more sugar per acre. In the case of 213 this is accounted for by increased tonnage only, while with 234 it was due both to greater tonnage and to higher sucrose content.

As among the P. O. J. varieties, 234 is the outstanding number in calculated yield of available sugar, having exceeded the others by from 500 to 600 pounds per acre. This was due mainly to its earliness and consequent higher analyses, since the differences in yield of cane are but slight. As to how much of this large difference is real and not the result of the thinner stand and heavy borer infestation of 213, or possible unequal effect of the drought, remains for future experimentation to show. At any rate, it is believed that the circumstances of the test have given 234 an unfair advantage over the 36 and 213. P. O. J. 36, particularly on account of its lateness, would be expected to give the best results as plant cane when cut late, and from ratoon crops. If this proves to be true, its larger barrel, greater ease of stripping, more erect growth habit, and vigorous root system would make it a desirable cane for this section, and it was largely for these reasons that the variety was recommended by the department.

TABLE 5.—*Yields of cane and laboratory analyses in cooperative test of sugar-cane varieties (spring plant cane) on the P. R. Landry plantation, Lafayette, La., 1926*

Variety	Equivalent acre yield of cane (tons of 2,000 pounds)										Sucrose in cane[1]			Fiber in cane[1] (per cent)	Juice analyses[2]		
	First plot	Second plot	Third plot	Fourth plot	Fifth plot	Sixth plot	Seventh plot	Eighth plot	Average	Average gain over Louisiana Purple	Per cent	Pounds per ton	Pounds per acre		Brix	Polarization	Purity
Louisiana Purple (control)	12.56	12.38	14.99	12.20	12.20	11.30	13.10	14.72	12.93	-------	11.23	224.6	2,904	10.5	16.65	13.75	82.5
P. O. J. 36	17.15	-------	15.98	14.63	18.05	14.76	-------	18.68	16.54	3.61	9.99	199.8	3,305	15.1	16.25	12.55	77.0
P. O. J. 213	14.58	17.24	18.77	14.27	16.52	12.92	17.33	18.23	16.23	3.30	10.12	202.4	3,285	14.5	15.75	12.65	80.4
P. O. J. 234	17.24	16.70	18.68	14.36	16.52	15.80	17.42	15.17	16.49	3.56	11.71	234.2	3,862	14.1	17.40	14.55	83.5
P. O. J. 826	-------	14.18	15.71	14.27	16.07	-------	15.62	15.26	15.19	2.26	11.05	221.0	3,357	11.6	16.35	12.65	77.2

[1] By direct analysis on shredded cane.

[2] Average juice analysis of 4 five-stalk samples expressed by laboratory mill.

TABLE 6.—*Data from mill test at Billeaud factory, Lafayette, La., November 11, 1926, of sugar cane from test on the P. R. Landry plantation*[1]

Variety	Weight of cane		Juice expressed		Per cent of juice extraction	Sucrose in juice expressed (pounds)		Sucrose in juice (pounds) per ton of cane		Available 96° sugar[2] (pounds per ton of cane)		Tons cane for 1 ton sugar	Tons cane per acre	Available 96° sugar[2] (pounds per acre)	
	Pounds	Tons (2,000 pounds)	Cubic feet	Pounds		Direct polarization basis	True sucrose basis	Direct polarization basis	True sucrose basis	Basis of juice extraction actually obtained	Basis of 78 per cent juice extraction			Basis of juice extraction actually obtained	Basis of 78 per cent juice extraction
Louisiana Purple	7,428	3.71	84.20	5,581	75.13	686.46	699.30	184.8	188.3	172.5	179.1	11.2	12.93	2,230	2,316
P. O. J. 36	7,312	3.66	76.37	5,050	69.06	555.50	571.66	151.9	156.4	135.5	153.1	13.1	16.54	2,241	2,532
P. O. J. 213	7,422	3.71	76.37	5,050	68.04	578.23	596.41	155.8	160.7	142.7	163.5	12.2	16.23	2,316	2,651
P. O. J. 234	9,178	4.59	97.91	6,512	70.95	859.58	870.65	187.3	189.7	176.4	194.0	10.3	16.49	2,909	3,199
P. O. J. 826	8,318	4.16	92.04	6,103	73.37	714.05	727.48	171.7	174.9	155.0	164.9	12.1	15.19	2,354	2,505

[1] No maceration water used.

[2] Winter-Carp (Java) formula and polarization and purity of mixed juice used; on basis of boiling house efficiency of 100 per cent.

TABLE 7.—*Analyses of mill juices in test of sugar-cane varieties grown on the P. R. Landry plantation, Lafayette, La., 1926*

Variety	Crusher juice					Crusher + first mill juice					Mixed juice from crusher and all mills				
	Brix (17.5° C.)	Polarization	Purity (apparent)	Per cent sucrose (Clerget)	Per cent "glucose" (reducing sugar as invert sugar)	Brix (17.5° C.)	Polarization	Purity (apparent)	Per cent sucrose (Clerget)	Per cent "glucose" (reducing sugar as invert sugar)	Brix (17.5° C.)	Polarization	Purity (apparent)	Per cent sucrose (Clerget)	Per cent "glucose" (reducing sugar as invert sugar)
Louisiana Purple	16.25	13.00	80.0			16.10	12.70	78.9	13.14	1.62	15.50	12.30	79.4	12.53	1.53
P. O. J. 36	15.60	12.05	77.2			15.50	11.70	75.5	12.08	1.91	14.95	11.00	73.6	11.32	1.86
P. O. J. 213	15.75	12.85	81.6			15.45	12.20	79.0	12.76	1.45	14.90	11.45	76.8	11.81	1.40
P. O. J. 234	17.20	14.50	84.3			16.80	13.95	83.0	14.09	1.12	16.35	13.20	80.7	13.37	1.14
P. O. J. 826	16.20	12.45	76.9			16.10	12.30	76.4	12.68	1.95	15.60	11.70	75.0	11.92	1.83

TABLE 8.—*Comparative differences in yields of sugar-cane varieties in test on the P. R. Landry plantation, Lafayette, La., 1926* [1]

Varieties compared with those in column headings at right	Increase (+) or decrease (−) in acre yield of cane and available sugar of varieties listed in first column as compared with those in column headings below									
	Louisiana Purple		P. O. J. 36		P. O. J. 213		P. O. J. 234		P. O. J. 826	
	Cane	Sugar	Cane	Sugar	Cane	Sugar	Cane	Sugar	Cane	Sugar
	Tons [2]	*Pounds*	*Tons* [2]	*Pounds*	*Tons* [2]	*Pounds*	*Tons* [2]	*Pounds*	*Tons* [2]	*Pounds*
Louisiana Purple			−3.61±0.56	−216±93	−3.30±0.51	−338±88	−3.56±0.51	−883±96	−2.26±0.56	−189±96
P. O. J. 36	+3.61±0.56	+216±93			+ .31± .56	−122±88	+ .05± .56	−667±96	+1.35± .61	+ 27±97
P. O. J. 213	+3.30± .51	+338±88	− .31± .56	+122±88			− .26± .51	−545±92	+1.04± .56	+149±92
P. O. J. 234	+3.56± .51	+883±96	− .05± .56	+667±96	+ .26± .51	+545±92			+1.30± .56	+694±100
P. O. J. 826	+2.26± .56	+189±96	−1.35± .61	− 27±97	−1.04± .56	−149±92	−1.30± .56	−694±100		

[1] Probable errors determined according to procedure outlined under heading of Table 4.

[2] Tons of 2,000 pounds.

The results of the experiment as a whole, therefore, show that even in a locality such as this, where fair yields are still obtained from the old varieties, a considerable increase is promised by the substitution of more vigorous canes.

SUMMARY

Results of the first season's comparative plot tests in Louisiana with disease-resistant sugar canes are presented, together with an outline of the department's aims and methods in the recently inaugurated varietal-testing project.

Laboratory mill juice analyses covering a three-year period and some fiber determinations of 12 P. O. J. varieties are listed.

In plot tests at the field station near Houma, La., severe borer damage to the cane used for seed in the fall of 1925 and unfavorable weather, including a destructive hurricane in the summer of 1926, damaged the stands to such an extent as to preclude yield comparisons in all but 4 of the 11 varieties planted, viz, P. O. J. 36, 213, 234, and 826. These were compared in duplicate on two widely different but representative soil types, and the uniformly favorable outcome, despite the various adverse circumstances, indicates a wide adaptability of these hardy canes to Louisiana conditions.

P. O. J. 213 was the outstanding variety, having exceeded all others on the heavy soil by 500 to 1,200 pounds of available sugar to the acre; but in the light-soil test, possibly because of more severe borer injury, it yielded about the same as P. O. J. 234.

P. O. J. 36 and 826 were about the same on both types of soil but were exceeded by the other two varieties on the light soil by at least 3 tons of cane and 400 to 500 pounds of sugar per acre. On the heavy soil they were not significantly lower in cane yield, but their relative lateness, combined with early harvesting, greatly reduced their potential sugar yields.

In a cooperative variety test near Lafayette, La., representing a third type of soil, in which the commonly grown Louisiana Purple was planted as a control, P. O. J. 213 and 234 were again the highest, yielding, respectively, 300 and 800 pounds more available sugar per acre than did Louisiana Purple. Here 234, solely because of richer juices, exceeded 213 by more than 500 pounds of sugar per acre. However, 213 was more severely damaged by borers, and the possible effect of the severe late-summer drought may also have influenced the result.

P. O. J. 36 and 826, while exceeding Louisiana Purple in tonnage of cane, were not proportionately higher in sugar, because of their naturally slower "ripening" and poorer juices at the comparatively early date at which they were harvested.

The Lafayette test as a whole shows clearly that even in a locality such as this, which thus far has suffered least from declining yields, large increases may be obtained by substituting hardier varieties for Louisiana Purple.

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